XLAM - FWP
Subtask List - FY2006

Task	PIs	Research Project
1	Shen, Greven	Spectroscopy & Scattering Study of Correlated Materials
2	Fisher, Beasley, Geballe	Novel Materials and Model Systems for the Study of Correlated Phenomena
3	Zhang, Laughlin, Kivelson	Condensed Matter Theory
4	Kapitulnik, Moler, Manoharan	Using local probes for the study of Nano-scale Phenomena in Complex Materials.
5	Stohr and Siegmann	Nano Magnetism
6	Melosh, Brongersma, McGehee	Behavior of charges, excitons and plasmons at organic/inorganic interfaces
7	Nilsson	Catalysis

Laboratory Name: XLAM/SSRL, SLAC
B&R Code: KC0202010

FWP and possible subtask under FWP:
Task 1 (Shen, Greven) Spectroscopy & Scattering Study of Correlated Materials

FWP Number: SCW0035

Program Scope:
Application of advanced photoelectron spectroscopy, x-ray scattering and neutron scattering methods to elucidate the electronic, magnetic, orbital and lattice properties of novel materials: (1) Conduct cutting edge research by correlating information gained from single particle (photoemission) and two particle (neutron and x-ray scattering) response functions. (2) Provide scientific impetus for developing state-of-the art capabilities at DOE's user facilities. (3) Develop crystal growth and characterization capabilities. These materials have enabled internal research at SLAC as well as extensive collaborations, nationally and internationally. (4) Develop human resources by training and educating students and post-docs.

Major Program Achievements (over duration of support):
Neutron scattering: new insight into the connection between antiferromagnetism and superconductivity in archetypical electron-doped cuprate NCCO, such as linear magnetic field effect on the superconducting magnetic gap; evolution of the instantaneous spin correlations from the antiferromagnetic to the superconducting phase; evidence for possible quantum critical point between these phases; demonstrated that pseudogap originates from spin correlations.
X-ray scattering: detailed Cu K-edge resonant inelastic X-ray scattering (RIXS) study of model Mott inulator La2CuO4 as a function of photon energy and polarization.
ARPES: the photoemission program remains active in its study of novel materials, in particular the strongly correlated complex oxides, with selected highlights here: new insights on anisotropic polaronic metallic state in colossal magnetoresistive manganites (Nature, 438, 474 (2005)); Direct observation of spin-charge separation in 1D $SrCuO_2$ (Nature Physics, 2, 397 (2006); Mass Renormalization in $SrVO_3$ (Phys. Rev. Lett., 95, 146404 (2005); Phanton Fermi Surface and Its Nesting Instability in $Ca_3Ru_2O_7$ (Phys. Rev. Lett. 96, 107601 (2006)); Doping Dependence of the Coupling of Electrons to Bosonic Modes in the Single-Layer Bi-Cuprate, Bi2201; (Phys. Rev. Lett., 96, 157003 (2006)); Fermi Surface and Quasiparticle Excitations of Sr_2RhO_4 (Phys. Rev. Lett., 96, 246402 (2006)).

Program Impact:
Provided fresh insights into electronic, magnetic and lattice properties for a number of important material families. Grow large single crystals of Hg-based compounds, the cuprates with the highest T_c, enabled collaborations.

Interactions:
Basov, DN (UCSD); Bontemps, B (ESPCI, France); Bourges, P (LLB, France); Bridges, F (UCSC); Brown, SE (UCLA); Casa, D (APS); Gog, T (APS); Homes, CC (Brookhaven); Ishii, K (Spring8, Japan); Kapitulnik, A (Stanford); Klein, MV (UIUC); van der Marel (Geneva, Switzerland); Mizuki, J (Spring8, Japan); Ong, NP (Princeton); Petitgrand, D (LLB, France); Rubenhausen, M (Hamburg, Germany); Uemura, Y (Columbia); Vajk, OP (Missouri); Hussain (ALS), Zaanen (Leiden); Fujimori, Uchida, Nagaosa (Tokyo); Devereaux (Waterloo); Eisaki (AIST); Baumberger, Mackenzie (St. Andrews); Kim (Yongsei); Ando (Criepi), Fisher (Stanford)

Recognitions, Honors and Awards (at least partly attributable to support under this FWP or subtask):
Large number of invited talks: Greven, Shen, Hancock, Mannella, Cuk; McMillan Award: Armitage; Student Poster award at SSRL users' meeting, Lee; Chaired Professorship at Stanford: Shen.

Personnel Commitments for FY2006 to Nearest +/-10%:
Z.-X. Shen 30%, M. Greven 20%, J. Hancock 100%, N. Barisic 20%, Y.-C. Cho 60%, X. Zhao 60%, G. Yu, 50%, G. Chabot-Couture 50%, L. Lu 50%, Y. Li 50%, Y. Chen 25%, M. Ji 25%, W.-S. Lee 50%, W. Meevasana 50%, F. Schmitt 50%, K. Tanaka 40%, W.-L.Yang 60%, X.-J. Zhou 25%, W. Dunkel 50%, T. Sasagawa 100%

Authorized Budget (BA) for FY04, FY05, FY06
FY04: $973K **FY05:** $1,023K **FY06:** $ 1,009K

Laboratory Name: XLAM/SSRL.SLAC
B&R Code: KC0202010

FWP and possible subtask under FWP:
Task 2 (Fisher, Beasley, Geballe) Novel materials and model systems for the study of correlated phenomena
FWP Number: SCW0035
Program Scope:
(1) Obtain fundamental understanding of correlated electron behavior in complex materials by creating and studying simpler systems; (2) Design and synthesis of materials for desired properties and functions; (3) Integration of high end physical characterization in the process of materials development; (4) Act as a national resource for materials development and characterization, and in training students in these fields.
Major Program Achievements (over duration of support):

Role of valence skipping elements in correlated electron behavior: Superconductivity observed in single crystals of Tl-doped PbTe. Thermodynamic and transport properties indicate exotic charge Kondo state passociated with mixed Tl valence (Tl^{+} and Tl^{3+}). Implication for pairing mechanism investigated.

Chemical pressure and CDW formation: Investigation of RTe_2, RTe_3 & R_2Te_5 (R = rare earth) reveal effect of band filling, "hidden 1-dimensionality" and chemical pressure on CDW formation. Substantial variation of T_{CDW} across rare earth series for RTe_3 attributed to effect of chemical pressure on bilayer splitting of Fermi surface. Reconstructed FS explored via dHvA and ARPES.

5d magnetism: Ba_2NaOsO_6 investigated as model $5d^1$ compound. Unusual appearance of ferromagnetism attributed to orbital ordering effects.

Correlation in $SrRuO_3$: Investigation of the photoemission spectra of $SrRuO_3$ thin films with varying cation stoichiometry shows that the degree of correlation in this material grows as the Ru vacancy concentration grows. This novel behavior also explains the difference in properties between MBE and PLD made films of $SrRuO_3$, which has been a long-standing mystery.

Charge ordering in CuO: We have successfully synthesized cubic thin films of the normally monoclinic compound CuO using epitaxial growth. The structure and valence of the CuO were confirmed by in situ RHEED, UPS and XPD (x-ray photo diffraction).

Conducting $LaAlO_3$/$SrTiO_3$ interfaces: The remarkable discovery of a conducting layer at the interface between these two insulators has been found to be a result of oxygen vacancies in the $SrTiO_3$ introduced by the PLD deposition process. A high mobility results due to the vary large dielectric constant of $SrTiO_3$, that permits the carriers to move well away from the dopant centers, as in modulation doping.
Program impact:
Materials physics: substantial advances in understanding aspects of correlated electron behavior.
New materials for DOE BES: extensive collaboration based on the materials developed in this program.
Interactions:
L. Balicas (NHMFL Tallahassee), C. Batista (MST11, LANL), D. Blank (University of Twente, Netherlands), Ivan Bosovic (BNL), F. Bridges (UCSC), S. Brown (UCLA), V. Brouet (LPS Orsay, France), K. Char (Seoul University, Korea), P. Coleman (Rutgers), J. R. Cooper (Cambridge, UK), L. DeGiorgi (ETH, Switzerland), S. Dodge (Simon Fraser University, Canada), S. Dugdale (Bristol, UK), E. M. Forgan (Birmingham,UK), P.M. Grant (EPRI), C. Gough (Birmingham, UK), W.A. Harrison (Stanford), Z. Islam (APS, ANL), A. Kapitulnik (Stanford), S. Kivelson (Stanford), L. Klein (Bar Elan University, Israel), G. Lukovsky (North Carolina State), A. Mackenzie (St. Andrews, UK), H. Manoharan (Stanford), G. Miller (Ames Laboratory), K. A. Moler (Stanford), J. Reiner (Yale), J. Schmalian (Ames Laboratory), S. Shapiro (BNL), Z. X. Shen (Stanford), M. Toney (SSRL),
Recognitions, Honors and Awards (at least partly attributable to support under this FWP or subtask):
MRB: 2002 Elected to the Board of Trustees of the Associated Universities Inc.
IRF: 2003 Sloan Research Fellowship; 2004 Terman Fellowship
Personnel Commitments for FY2006 to Nearest +/- 10%:
I. R. Fisher (10%), M. R. Beasley (10%), T. H. Geballe (0%),
Y. He (10%), K. Munakato(10%), P. SanGiorgio (50%) G. Koster (25%), A. Erickson (50%), Y. Matsushita (50%), N. Ru (50%), K. Y. Shin (50%)
Authorized Budget (BA) for FY04, FY05, FY06:
FY04 BA \$360k **FY05 BA** \$417k **FY06 BA** \$500k

Laboratory Name: XLAM / SSRL, SLAC
B&R Code: KC0202030

FWP and possible subtask under FWP:
Task 3 (Zhang, Laughlin, Kivelson) : Theory of Condensed Matter Physics, including 1) nano-scale magnetism, 2) spin transport in semiconductors and 3) correlated-electron phase diagrams and 4) interaction of matter with high-intensity X-rays.

FWP Number: SCW0035, SCW0046

Program Scope: The Stanford condensed matter theory group includes Doniach, Laughlin, Kivelson and Zhang. It presently emphasizes strongly-correlated systems, complex quantum phase diagrams and spin transport. It is broadening its scope to include computational materials physics and the interaction of matter with high-power radiation.

Major Program Achievements (over duration of support):
Zhang has had activity in three major areas. 1.) He predicted the Pair Density Wave (PDW) state, a charge-ordered state of Cooper pairs, and argued that it is seen scanning tunneling microscope measurements of underdoped high-Tc cuprates. He identified the key signature of this state to be a fourier-transformed local density of states that is an even function of the bias energy. 2.) He proposed a way to eliminate spin decay in semiconductors due to spin-orbit coupling, in the process discovering a new type of SU(2) spin rotation symmetry. He made this happen by forcing the Rashba and Dreselhouse coupling constants to be equal. The infinite spin lifetime at a particular wavevector that results gives rise to a Persistent Spin Helix (PSH), an effect which has now been observed in [110] quantum wells by Joe Orenstein's group at Lawrence Berkeley Laboratory. 3.) He predicted a new topological quantum phase transition between a conventional insulator and a Quantum Spin Hall state. The latter is characterized by a single pair of helical edge states. He proposed to look for this effect in HgTe/CdTe semiconductor quantum wells. This paper has been accepted for publication in Science.

Kivelson is a new member to the group. He replaces Doniach next year. He plans to work on superconductivity in small Hubbard clusters, phenomenology of high-correlated materials and the physics of nanoscale measurement.

Doniach last year proposed that d - wave superconductivity might occur in graphite composites. He proposed ways to observe this effect and identify the underlying mechanism experimentally. Doniach will leave the program.

Laughlin has been on leave from Stanford the past two years serving as President of the Korea Advanced Institute for Science and Technology (KAIST). He has now returned to Stanford and plans to direct his research to the interaction of high-intensity X-rays with matter. He is most interested in new physical effects that might occur at maximal focus of the X-ray free-electron laser.

Program Impact:
Invited talks at the International Conference on Materials and Mechanisms of Superconductivity, Dresden, Germany 2006. High profiled publications in Science and Physical Review Letters. DoE laboratory experience, including this program, contributed to Prof. Laughlin's invitation to Korea and subsequent influence on technological investment decisions there in displays, circuit design, ubiquitous computing, process engineering and metallurgy.

Interactions:
PC Dai (Oakridge National Lab), W Hanke (University of Wuerzburg), A Yazdani (Princeton). Beasley, Fisher, Geballe, Goldhaber-Gordon, Greven, Katitulnik, Moler and Shen (Stanford).

Recognitions, Honors and Awards (at least partly attributable to support under this FWP or subtask):
Fellow of the American Physical Society (Zhang)

Personnel Commitments for FY2006 to Nearest +/-10%:
S.C. Zhang 10%, S. Doniach 30%, R. Laughlin 20%, A. Black-Schaffer (50%), A. Bernevig 20%

Authorized Budget (BA) for FY04, FY05, FY06:
FY04 BA $218K **FY05 BA $**218K **FY06 BA** $354K

Laboratory Name: XLAM/SSRL, SLAC
B&R Code: KC0202010

FWP and possible subtask under FWP:
Task 4 (Kapitulnik, Manoharan, Moler) Using local probes for the study of Nano-scale Phenomena in Complex Materials.

FWP Number: SCW0035

Program Scope:
A collaborative research program focusing on the physics of nanoscale ordering phenomena in complex materials. The objectives of the program include: i) Development of new tools for the study of correlated materials, with emphasis on the nano-scale; ii) Deeper scientific understanding of correlated electron phenomena. By investigating model systems that address key physical effects found in many complex materials, including competing interactions, coexisting phases and their emergence from the nano-scale to bulk properties; iii) Study of new materials. The heart of this proposal is the collaboration with groups who develop new materials which may be used to answer critical scientific questions, or may be used for future applications. This approach is unique and involves state of the art facilities. New phenomena will lead to the invention of new ways to investigate them and vice versa. This program will therefore strengthen the wider DOE effort in nano-scale physics in the US; iv) Act as a national resource for the study of the development and characterization of novel materials using novel tools, and in training students and other technical personnel in these fields.

Major Program Achievements (over duration of support):
STM Studies: Diamond molecules derived from individual cages of a diamond crystal (diamondoids), were created and imaged for the first time with STM. Studies of $TbTe_3$ using STM showed an incommensurate CDW structure.
Local Magnetic Measurements: Showed that a theoretically predicted signature of time-reversal-symmetry breaking superconductivity in Sr_2RuO_4 does exist, using a Novel magneto-optic device based on the Sagnac effect.
Preliminary results on discovery of very small broken time reversal symmetry effect in $YBa_2Cu_3O_{7-}$ as a function of doping.
Demonstrated 100-nm scanning Hall probes with sensitivity of one one-thousandth of a superconducting flux quantum.
Prepared Sr2RuO4 single crystals in geometries suitable for detection of edge current.
Improved understanding of expected magnetic signals from time-reversal-symmetry breaking superconductors such as Sr2RuO4.

Program Impact:
Power of local measurements has been demonstrated to investigate global properties of strongly correlated materials. New magneto-optic device that can impact the field of magnetic memory.

Interactions:
At Stanford: I.R. Fisher, M. Greven, M.R. Beasley and T.H. Geballe, S. Kivelson, S. Doniach, S.C. Zhang, N. Melosh, Z.X. Shen, M.M. Fejer and Eun-Ah Kim. Outside Stanford: P. C. E. Stamp, G. Sawatzky and R. Harris (UBC, Canada), B. A. Jones, C. P. Lutz, A. S. Heinrich, D. M. Eigler (IBM Almaden, USA), E. J. Heller (Harvard, USA), E. Fradkin (UIUC, USA), John Tranquada (BNL, USA), Yoshiteru Maeno, Kyoto, Japan), Maeno group (Kyoto), John Berlinsky and Catherine Kallin (McMaster).

Recognitions, Honors and Awards (at least in some part attributable to support under this program):
A. Kapitulnik was awarded a Sackler Professorship by Tel Aviv University, Israel.

Personnel Commitments for FY2006 to Nearest +/- 10%:
A. Kapitulnik (10%), H. Manoharan (10%), K. Moler, (10%), A. Fang (50%), G. Zeltzer (15%), L. S. Mattos (20%,), B. K. Foster (10%), C. R. Moon (10%), C. Hicks (50%)

Authorized Budget (BA) for FY04, FY05, FY2006:
FY04 BA $368k **FY05 BA $**431k **FY06 BA $**412k

Laboratory Name: XLAM/SSRL, SLAC
B&R Code: KC0202010

FWP and possible subtask under FWP:
Task 5 (Stohr,Siegmann) Nano Magnetism

FWP Number: FWP-SCW0035

Program Scope:
The general goal of this program is to explore spin currents and the associated quantum mechanical exchange interaction for the excitation and switching of the magnetization in magnetic nanostructures. In particular, our program is based on the use of unique time-dependent x-ray imaging techniques with tens of nanometers spatial and tens of picoseconds temporal resolution. We also propose to explore the concept of a spin current amplifier, an important yet unrealized device, that is also based on spin injection.

Major Program Achievements (over duration of support):
We have developed x-ray imaging techniques with 30 nm spatial and a temporal resolution down to 100 ps. Using time-dependent scanning transmission x-ray microscopy we have directly imaged the changes induced in buried magnetic sensor layers of nanoscale (~100 nm) dimensions by spin currents. Ultrafast x-ray motion pictures reveal a fast, sub-nanosecond switching process based on the lateral displacement of a magnetic vortex. While the motion of vortices is omnipresent in nature, their role in magnetic switching has previously remained unrecognized or unappreciated. Our measurements show how the injected spin current laterally displaces magnetic vortices created by the curled Oersted field of the accompanying charge current. The new fundamental switching process is intriguing in that it is accelerated by the curly Oersted field. We also discovered that it may result in metastable final states which are undesirable in technological applications.

We have also begun work on a spin current amplifier. As a possible implementation we are exploring the use of a ferromagnet above T_C (i.e. a paramagnet) and a temporal three step process. In the first step, the paramagnet is driven into the ferromagnetic state by injection of the spin-polarized current to be amplified. The ferromagnetic state, reflecting the spin polarization of interest, is then frozen in by lowering the temperature. In the third step the oriented ferromagnet is used as a polarizer (spin filter) of an unpolarized current of sufficient strength to create a spin polarized output current that is amplified relative to the original spin polarized signal. We have succeeded in constructing a conceptual structure by e-beam lithography. Our employed lateral geometry separates charge and spin currents and eliminates any Oersted fields at the position of the nanomagnet due to charge current flow. Only the spin current is used to polarize the nanomagnet. We will use x-ray microscopy to investigate the response of the nanomagnet, kept slightly above T_C, to the spin current.

Program impact:
In 2006, the work has resulted in 10 invited talks which were given by Y. Acremann and J. Stohr at international conferences.
Y. Acremann, J. P. Strachan, V. Chembrolu, S. D. Andrews, T. Tyliszczak, J.A. Katine, M. J. Carey, B. M. Clemens, H. C. Siegmann, J. Stöhr, Phys. Rev. Lett. **96**, 217202 (2006)

Interactions:
The work involved lithographic sample preparation in collaboration with Jordan Katine and Matt Carey at Hitachi Global Storage Systems in San Jose, California. Experiments were carried out in collaboration with Tolek Tyliszczak at the Advanced Light Source.

Personnel Commitments for FY2006 to Nearest +/- 10%:
Y. Acremann 50%, J. P. Strachan 100%, V. Chembrolu 100%, X. Yu 100%, H. Siegmann 20%, B. Clemens 10%

Authorized Budget (BA) for FY04, FY05, FY06:
FY04 BA \$350K **FY05 BA** \$350K **FY06 BA** \$350K

Laboratory Name: XLAM/SSRL, SLAC
B&R Code: KC0203010

FWP and possible subtask under FWP:
Task 6 (Melosh, McGehee, Brongersma) Behavior of Charges, Excitons and Plasmons at organic/Inorganic Interfaces

FWP Number: SCW0034

Program Scope:
Exciton transport and molecular wavefunction coupling to metal electrodes on the molecular level (~1 nm). Exciton and charge transport within semiconducting polymer films close to metallic electrodes or dielectric films (5-100 nm). Exciton coupling to surface plasmon waves on metal surfaces within the 10-500 nm range. Molecular band line up changes during charge transport, effect of chemical linkage to electrode on band line up and tunneling properties.

Major Program Achievements (over duration of support):
Charge transport in semiconducting polymers: Used synchrotron x-ray diffraction to show that charge carrier mobility is highest in polymer transistors when crystals nucleate off of the gate dielectric. When the crystals do not nucleate off of the dielectric, they are not all aligned with each other and the insulating side chains prevent charge hopping from one grain to another.

Exciton transport in semiconducting polymers: Showed that many exciton diffusion lengths reported in the literature are overestimated due to not accounting for optical interference effects. The diffusion length in most polymers used for solar cells is 3-6 nm. Showed that exctions can be harvested over 25 nm by choosing donor and acceptor polymers that enable Förster resonance energy transfer. (Scully and McGehee, *Journal of Appl. Phys*, 100 (2006), 034907-1)

Transport at the molecular scale: Developed a new method to softly contact molecular monolayers with a large area (>mm^2) top metal electrode without shorting or damaging the molecular monolayer. Developed surface plasmon spectroscopy apparatus and demonstrated direct optical absorption measurements of a single monolayer between two metal electrodes. Demonstrated coupling into the metal-insulator-metal (MIM) mode using a grating. Calculated intensities within the MIM structure are 10^4 higher than standard plasmon modes. (Shimizu et al., *Nanoletters*, DOI 10.1021/nl061893h)

Radiative decay engineering: Performed simulations of the emission enhancement for a dipole emitter placed in a subwavelength metal optical cavity. Designed, fabricated, and tested an organic light emitter that exploits the metallic contacts for both the charge injection and obtaining a virtually omni-directional emission. Performed electromagnetic simulations to enhance the light emission from light-emitting devices with two metallic contacts by making them virtually transparent. Liu et al, Appl. Phys. Lett. 2006, in press.

Program impact:
The understanding gained from this research will enable the fabrication of more efficient organic solar cells, the extraction of more light from light emitting diodes that can be used for displays or solid-state lighting, and the fabrication of better molecular electronics devices and optical switches.

Interactions:
U.C. Berkeley: J. Fréchet; Stanford University: Z. Bao, M. Toney (SLAC)

Recognitions, Honors and Awards (at least partly attributable to support under this FWP or subtask):
M.D. McGehee was a Gilbreth Lecturer at the 2006 National Academy of Engineer's Frontiers of Engineering Meeting and has give 13 invited talks related to this project. M.L Brongersma had 11 invited talks and 1 invited tutorial related to this project. N.A. Melosh has given 6 invited talks, was part of a Gordon Research Conference on this subject.

Personnel Commitments for FY2006 to Nearest +/- 10%:
Melosh 5 %, Brongersma 5 %, McGehee 5 %, S Scully 50 %, N Devani 50 %, J Liu 50 %

Authorized Budget (BA) for FY05, FY06, FY07:
FY05 BA $275,000 **FY06 BA $275,000** **FY07 BA $275,000**

Laboratory Name: XLAM/SSRL, SLAC
B&R Code: KC0202010

FWP and possible subtask under FWP:
Task 7 (Nilsson) Catalysis

FWP Number: SCW0040

Program Scope:
This program is aimed to develop new synchrotron radiation based x-ray diffraction and spectroscopy methods that allow in-situ probing of the intermediates in the catalytic cathode process in fuel cells where both species identification, geometric and electronic structure properties can be fully characterized. The mechanistic understanding provides new insights on how to design new low Pt containing alloy catalyst. In parallel to the fundamental synchrotron work, theory-guided combinatorial synthesis and high throughput electrochemical screening methodologies for fuel cell cathode catalysts are being developed and applied in order to link mechanistic hypotheses and catalyst testing under realistic conditions in high dimensional compositional and process parameter spaces.

Major Program Achievements (over duration of support)
- Characterized the mixed OH and water phases on Ru(001), Pt(111), Cu(110) and Cu(111) surfaces with XPS, XAS and STM under ultrahigh vacuum and ambient conditions in equilibrium with water at 1 torr. Established poison of the oxygen dissociation step due to the presence of water and OH-water mixed phase on Pt(111). Demonstrated that the reduction of OH-water mixed phase to water with hydrogen requires free Pt sites on Pt(111). All these results points to the importance of the 3 phase boundary for the ORR reaction.
- Synthesized and characterized over 100 Pt-M binary and Pt-M-M ternary carbon supported electrocatalysts including Pt-Co, Pt-Cu and Pt-Cu-Co alloys.
- Established structure-activity-stability relationships of Pt-Co binary electrocatalyst for the electroreduction of oxygen (ORR) using synchrotron X-ray diffraction techniques; established the impact of atomic ordering of Pt-Co phases on their electrocatalytic activity and stability: Ordered Pt50Co50 phases are very stable but not very active for ORR, disordered Co rich (> 50at% Co) Pt-Co phases are very active ORR phases but show low corrosion stability.
- Established a novel synthesis method for the preparation of highly active oxygen reduction electrocatalyst using rapid de-alloying of base metal rich precursor catalysts. Established a novel hypothesis that Pt bulk lattice strain may play a crucial role in the enhancement mechanism of rapidly de alloyed precursor materials.
-Designed and validated a in-situ electrochemical Small Angle X-ray Scattering (SAXS) cell for use at SSRL beam lines 1-4 and 4-2. Achieved in-situ and ex-situ SAXS measurements of Pt alloy corrosion and Ostwald ripening phenomena in electrochemical diffusion layers, including the use of anomalous SAXS. Established favorable correlations between XRD and SAXS analytics of Pt alloy electrocatalysts

Program Impact
This program has the potential to have a large impact on the future Hydrogen Fuel Initiative. Fuel cells are currently considered as the most promising power generation technology for a sustainable energy infrastructure.

Interactions:
A. Nilsson, M. Toney, H. Ogasawara, L. Leisch, L. Å, Näslund, T. Anniyev (SSRL), P. Strasser, S. Koh, P. Mani (University of Houston), Lars Pettersson, Michael Odelius, (Stockholm University, Sweden) and J. Norskov (Danish Technical University, Denmark).

Personnel Commitments for FY2006 to Nearest +/- 10%:
A. Nilsson 10%, H. Ogasawara 100 %, M. Toney 10%, J. Leisch 100% (SSRL)
P. Strasser 10%, S. Koh 100%, P. Mani 100% (UH)

Authorized Budget (BA) for FY05, FY06, FY07:
FY05: \$600K **FY06:** \$600K **FY07:** \$600K